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WORKSHOPS OF THE SOO (2008 HAVRE). SYMPOSIUM: TOTAL KNEE ARTHROPLASTY

## Total knee arthroplasty in patients with greater than 20 degrees flexion contracture

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### KEYWORDS

Total knee  
arthroplasty;  
Stiff knee;  
Flexion contracture

**Summary** Does total knee arthroplasty (TKA) correct the flexion contracture in knee stiffness associated with osteoarthritis, inflammatory disease, hemophilia or post-traumatic sequelae? The results of 107 TKAs from five specialized centers were retrospectively reviewed. Only knees with greater than or equal to 20° flexion contracture on extension were included, 46 of which also had less than 90° flexion. As a result of the arthroplasty, extension increased by  $20 \pm 6^\circ$  in group 1 (flexion contracture only,  $n=61$ ), and by  $22 \pm 11^\circ$  in group 2 (combined stiffness,  $n=46$ ), in which the total range of motion increased of  $39 \pm 21^\circ$ . Overall, mean residual flexion contracture was  $7 \pm 7^\circ$ . Improvements in mobility were greater in the cases with severe preoperative stiffness. One-year functional results correlated with final residual flexion contracture. Mobility at last follow-up did not depend on preoperative mobility, except in group 2, in which the final postoperative range of motion (ROM) correlated with preoperative ROM. Hemophilia was a factor of poor prognosis. Recovering full extension at end of surgery is mandatory, by first releasing the posterior capsule and the collateral ligaments from their osteophytes, and secondly by extending the distal femoral cut where necessary.

Type of study: Level 4 retrospective.

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### Introduction

The technical problems involved in total knee arthroplasty (TKA) for knee stiffness vary according to the type and

degree of stiffness. Flexion contracture, or stiffness on extension (passive extension deficit), is both frequent and hard to correct. TKA is intended to achieve optimal flexion contracture correction. For contractures of 10° or more, particular techniques, performed in a specified order, may be required. The literature recommends limiting bone resection to the most severe cases, with mandatory release of the posterior capsule and the collateral ligaments [1–4].

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A symposium was held, to collect retrospective data from several centers specializing in this kind of surgery, with a view to specifying adapted strategies for various types of knee stiffness, analyzing results at one year according to pre-operative severity, etiology, history of surgery, and specific release techniques associated to conventional surgery.

One hundred and seven cases of TKA for preoperative flexion contracture equal to or greater than 20° were retrospectively selected in five centers. Results were analyzed in terms of mobility as assessed clinically over the first year of follow-up, whether by goniometry or "visually".

## Methods

Records for consecutive first-intention TKA performed between September 2000 and September 2006 in five centers in western France were retrospectively examined. A follow-up period of one year was required for inclusion, given that mobility remains relatively stable thereafter [5,6].

Mobility was assessed "visually" at postoperative check-ups, in terms of absolute flexion and extension and of absolute and relative gain. Absolute extension gain was defined as the difference between preoperative and last follow-up passive extension, and relative gain as absolute gain divided by the preoperative mobility score, thereby relating gain to the severity of preoperative stiffness.

The range of motion (ROM) between maximum extension and maximum flexion was the main criterion for cases of combined stiffness. Results were therefore expressed in terms of absolute and relative mobility gain, and were considered "excellent" in case of less than 10° residual flexion contracture and greater than 90° final flexion, "good" in case of 10–15° residual flexion contracture and 70–90° final flexion, "moderate" in case of 10–15° residual flexion contracture and 50–70° final flexion, and otherwise "poor".

Clinical scoring used a simplified version of the IKS scale. Three functional parameters were regularly to be found in the records: climbing up and down stairs, use of a walking cane, and walking distance. Climbing up and down stairs and walking distance were scored positively out of 50 points and use of a walking cane negatively out of 20 points, the sum of the three giving a total score. Scores of more than or equal to 90 were considered excellent, 79–89 good, 60–69 moderate, and less than 60 poor. Pain was scored separately, on a 50-point scale.

### Group 1 (simple extension stiffness)

Group 1 (simple extension stiffness) comprised 61 patients followed up at six months, 43 of whom were also followed up at one year. Table 1 presents demographic data. Nine knees had been previously operated (osteotomy or osteosynthesis), including two with multiple (> 2) scars. Etiologically, there were three main groups, comparable for age: 30 cases of idiopathic osteoarthritis (36 varus, 3 valgus), eight of inflammatory arthritis, and nine of post-traumatic arthritis (3 sprain sequelae, and 3 femoral, 2 tibial and 1 patellar malunion). Remaining etiologies included hemophilia ( $n=3$ ) and bacterial arthritis ( $n=2$ ). Mean preoperative flexion

**Table 1** Preoperative data for the two stiffness groups.

	Extension stiffness $n=61$	Combined stiffness $n=46$
Age	67 ± 13 yrs	58 ± 15 yrs
Sex ratio	31F/30M	22F/24M
Etiology		
Idiopathic knee osteoarthritis (%)	64	31
Inflammatory arthritis (%)	13	19
Post-traumatic knee arthritis (%)	15	16
Hemophilia (%)	5	28
Other (%)	3	6
Preoperative stiffness		
Mild (%)	40	53
Moderate (%)	54	28
Severe (%)	6	19

contracture was  $26 \pm 7^\circ$  (20–60°), with no significant difference between the three main etiological groups.

Specific release techniques additional to resection of anterior osteophytes were performed in 41 cases: a distal femoral cut, mainly to open extension space, and release of the posterior capsule retracted by osteophytes. Eight cases required additional bone cuts only (5 distal femoral and 3 tibial cuts), and 11 involved isolated soft tissue surgery (posterior capsule release). Twenty-one cases associated bone cuts (16 femoral and 5 tibial cuts) to posterior capsule release.

Preoperative flexion contracture was considered mild at 20° (24 patients), moderate at 20–30° (33 patients) and severe when greater than 30° (4 patients). Bone resection was systematic in case of severe contracture, with associated posterior capsule release in three cases. No correlation was, however, found between the frequency of release surgery, whether osseous, ligamentary or combined, and preoperative flexion contracture severity ( $p=0.5$ ).

All patients received posteriorly stabilized implants, 27 with hypercongruent insert and 34 with stabilizing camshaft.

### The combined stiffness group

The combined stiffness group comprised 46 knees with six months' follow-up, including 35 with one year's follow-up. Fifteen had been previously operated. There were three main groups of etiology: 14 cases of idiopathic osteoarthritis (7 varus, 5 valgus and 2 femoro-patellar), nine of inflammatory arthritis, and 13 of hemophilia. Mean age was significantly younger in the latter two groups: 52 years [21–71] versus 68 years [55–81];  $p=0.001$ . Remaining etiologies included seven cases of post-traumatic arthritis, two of bacterial arthritis sequelae and 1 condylar necrosis. Mean preoperative flexion was 77° (35–90°), and mean preoperative flexion contracture 28° (20–60°), giving a mean ROM of 49° (0–70°). Stiffness was greater in case of inflammatory arthritis and hemophilia than in idiopathic osteoarthritis, in terms of both flexion (73° [40–90°] versus 85° [70–90°]) and flexion contracture (34° [20–60°] versus 24° [20–30°]).

Mean ROM in hemophilia ( $33 \pm 20^\circ$ ) was significantly less than in idiopathic osteoarthritis ( $60 \pm 9^\circ$ ,  $p=0.001$ ), but not significantly different from the ROM found in inflammatory arthritis ( $47 \pm 28^\circ$ ,  $p=0.2$ ), which in turn did not significantly differ from that found in idiopathic arthritis ( $p=0.1$ ).

There were four cases of ankylosis, five of severe stiffness (ROM =  $10-35^\circ$ ), 13 of moderate stiffness (ROM =  $35-50^\circ$ ) and 24 of mild stiffness (ROM =  $55-70^\circ$ ).

Soft-tissue release surgery was performed in more than half of the cases overall (19 posterior capsule releases and 5 arthrolyses). Thirty-four patients required additional bone cuts (14 distal femoral, 8 tibial, and 12 associated femoro-tibial resection extensions). Such bone and ligament surgery was restricted to cases of severe stiffness and ankylosis.

In terms of technique, 20 anterior tibial tuberosity osteotomies were required. All implants were semi-stressed, with posterior stabilization (28 hypercongruent and 18 with stabilizing post cam).

### Statistical analysis

The impact of preoperative stiffness severity, etiology, history of surgery, associated release surgery, and condylar offset alteration on postoperative results was studied. Qualitative variables were compared by Chi<sup>2</sup> test (with Yates correction for small sample size): e.g., for the percentage of good, moderate and poor results according to etiology or preoperative severity. Quantitative values were correlated by Spearman test, given the small sample sizes: e.g., pre- and postoperative mobility, or functional score and ROM at last FU. Finally, the Student test for small samples was used to compare mean ROM or ROM gain between two groups (such as with or without history of surgery), or mean age between two etiologies. *P*-values are stated for each comparison; the significance threshold was set at 0.05.

### Simple extension stiffness results

Tables 2 and 3 show results for the two groups. Mean flexion contracture at end of follow-up was  $7^\circ$  ( $0-20^\circ$ ) with a standard deviation of  $6^\circ$ . Only 25 knees were free of contracture, and 12 with mild contracture of less than  $10^\circ$ . Otherwise, residual flexion contracture exceeded  $10^\circ$ , and exceeded  $15^\circ$

**Table 2** Functional and mobility results for the two stiffness groups.

1 year's FU	Extension stiffness <i>n</i> = 43	Combined stiffness <i>n</i> = 35
<b>Mobility result</b>		
Excellent (%)	41	45
Good (%)	20	20
Moderate (%)	29	6
Poor (%)	10	29
<b>Functional result</b>		
Excellent (%)	42	37
Good (%)	32	33
Moderate (%)	10	20
Poor (%)	16	10

**Table 3** Mean, preoperative mobility and flexion, extension and range of motion gain at last FU for the two stiffness groups.

	Extension stiffness <i>n</i> = 61	Combined stiffness <i>n</i> = 46
<b>Preoperative mobility</b>		
Extension	$26 \pm 7^\circ$	$28 \pm 10^\circ$
Flexion	$111 \pm 10^\circ$	$77 \pm 16^\circ$
<b>Mobility gain</b>		
Extension	$20 \pm 6^\circ$	$22 \pm 11^\circ$
Flexion	$7 \pm 5^\circ$	$17 \pm 15^\circ$
ROM	$15 \pm 19^\circ$	$39 \pm 21^\circ$

in six cases i.e., flexion contracture failed to be satisfactorily corrected ( $> 10^\circ$ ) in 24 cases (39%) (Fig. 1).

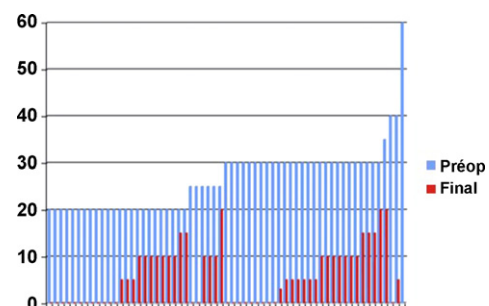
Mean extension gain (postminus preoperative flexion contracture) was  $20^\circ$  ( $5-40^\circ$ ), for a mean improvement of  $75 \pm 24\%$  ( $20-100\%$ ).

Preoperative flexion contracture severity did not correlate with residual contracture ( $p=0.5$ ). The greater the preoperative flexion contracture, however, the greater the absolute ( $r=0.48$ ;  $p=0.0001$ ), although not the relative extension gain ( $r=-0.05$ ;  $p=0.7$ ). That is to say: a mild flexion contracture is no easier to correct than a severe one.

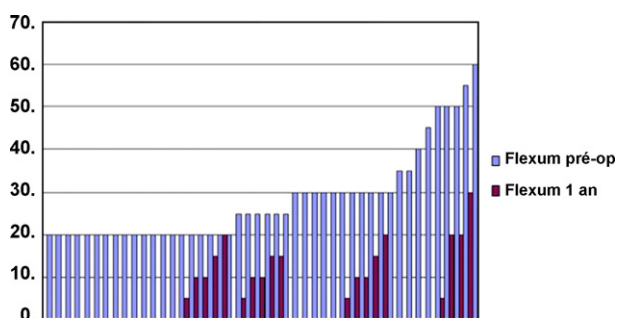
Etiology (idiopathic, post-traumatic or inflammatory osteoarthritis), specific surgery (notably additional bone cuts), previous surgery or preoperative femoro-tibial alignment did not correlate with final flexion contracture (etiology:  $p=0.2$ ; associated surgery:  $p=0.3$ ; previous surgery:  $p=0.5$ ; preoperative malalignment:  $p=0.6$ ). Nor did the degree of surgical alteration to the posterior condylar offset ( $r=0.1$ ). Relative extension gain tended to be greater in case of associated surgery ( $75 \pm 25\%$  versus  $64 \pm 31\%$ ;  $p=0.17$ : NS).

For the 43 patients followed up at both six months and one year, relative extension rose from  $72 \pm 27\%$  to  $75 \pm 24\%$  between the two assessments ( $p=0.59$ : NS): i.e., a relative gain of 8% and absolute gain of  $2^\circ$ . Twenty-six knees showed some further improvement, and five lost some degrees of extension.

Functional results at one year, available for 43 patients, were excellent in 42% of cases, good in 32%, moderate in 10% and poor in 6%. They correlated strongly with residual flexion contracture ( $r=0.76$ ;  $p=0.01$ ).



**Figure 1** Diagram of residual flexion contracture according to preoperative values, in increasing order, in the extension stiffness group.



**Figure 2** Diagram of residual flexion contracture according to preoperative values, in increasing order, in the combined stiffness group.

No significant complications were recorded in this patient group.

### Combined stiffness results

Mean flexion contracture at end of follow-up was  $7 \pm 8^\circ$  ( $0-30^\circ$ ). Only 16 knees were contracture-free, and 10 with mild ( $\leq 10^\circ$ ) contracture. The other patients showed residual flexion contracture greater than  $10^\circ$ , including nine greater than  $15^\circ$ . i.e., flexion contracture failed to be satisfactorily corrected ( $> 10^\circ$ ) in 20 cases (43%) (Fig. 2).

Mean extension gain was  $22 \pm 11^\circ$  ( $0-60^\circ$ ), for a mean improvement of  $77 \pm 25^\circ$  ( $25-100^\circ$ ). Mean ROM at last FU was  $89^\circ$  ( $60-130^\circ$ ).

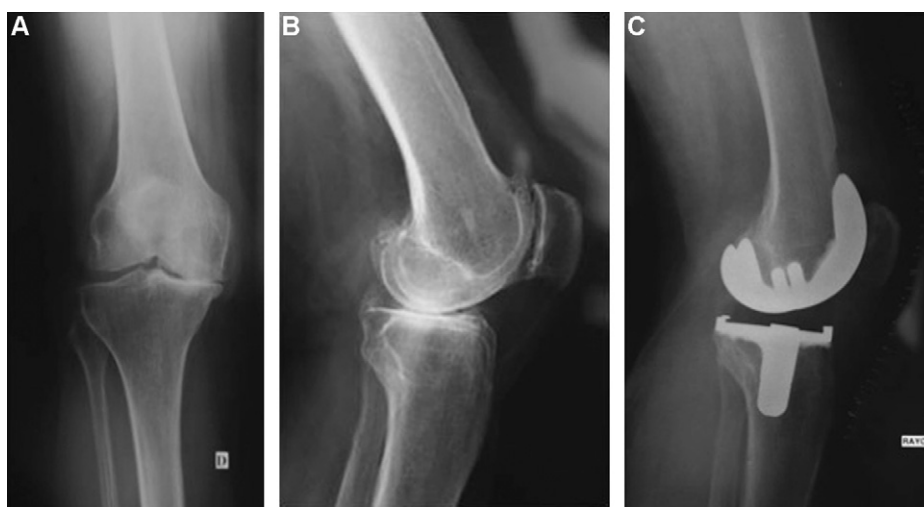
On our above criteria, there were ten poor results at one year (29%), two moderate (6%), seven good (20%) and 16 excellent (45%). Moderate stiffness gave the best results (significant, at  $p=0.01$ ). Final and preoperative range of motion correlated significantly ( $r=0.43$ ;  $p=0.02$ ), unlike preoperative malalignment ( $r=0.01$ ;  $p=1$ ). Hemophilia had a significant negative impact on the final result ( $p=0.001$ ). Specific osseous and/or ligamentary release surgery had no significant impact on results at one year ( $p=0.3$ ): nor did

previous surgery ( $p=0.9$ ). Tibial slope more than  $5^\circ$ , however, correlated significantly with final mobility ( $p=0.05$ ), unlike variation in posterior condylar offset ( $p=0.06$ ).

Of the 30 patients with complete functional scores at one year, the overall final functional result was excellent in 37% of cases, good in 33%, moderate in 20% and poor in 10%. Functional score correlated with neither final flexion, residual flexion contracture nor final ROM ( $r=0.18$ ,  $0.17$  and  $0.14$ , respectively;  $p>0.2$ ). Complications recorded in this group comprised one infection, two fractures and one non regressive fibular nerve palsy.

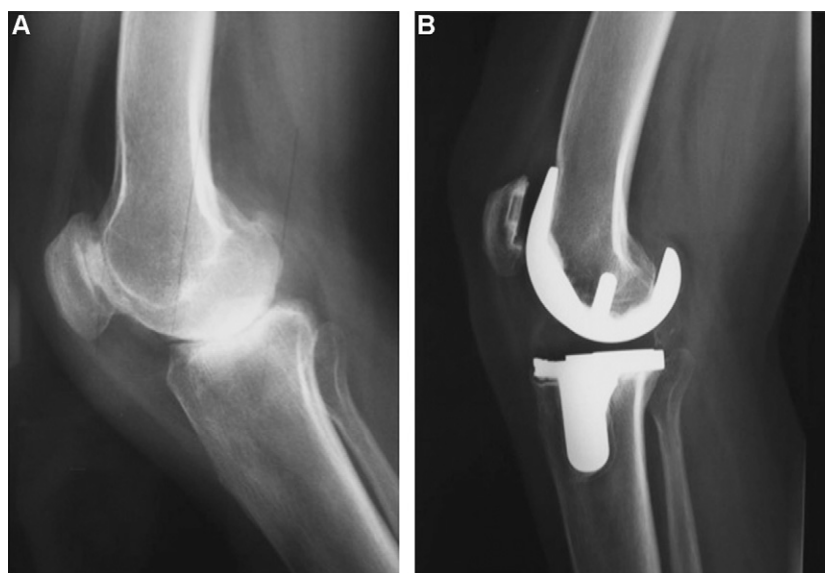
### Discussion

Flexion contracture correction is a systematic objective in TKA, along with pain reduction. It would seem to entail a certain quality in the functional result, as seen from the significant correlation between functional score and residual contracture in the first group. In the present series, no patients lost and all gained extension, to a variable degree. That only 40 or so achieved complete contracture correction shows how difficult TKA objectives are to attain. Some authors have stressed the need for a stereotyped procedure to achieve complete contracture correction at end of surgery [2,7]. Firestone et al. [4] and Ritter et al. [8] long ago showed the degree of preoperative residual flexion contracture to impact final extension recovery. Berend et al. [1], with this in mind, corrected flexion contracture down to less than  $10^\circ$  in over 94% of cases in his series, as compared to 59% of cases in the present symposium. Likewise, Bellemans et al. [2] corrected flexion contracture down to less than  $15^\circ$  in 86% of their cases, with a design essentially comprising collateral ligament release by osteophyte ablation and a 2 mm femoral bone cut in the overwhelming majority of cases (98%). Mihalko et al. [9] stress the need to achieve balance in the femoro-patellar space, and warn against insufficient implant trochlea clearance. Although the present results failed to show any benefit with release surgery, the importance of releasing soft parts,



**Figure 3** X-ray: 70-year-old female patient presenting with medial femoro-tibial osteoarthritis of the knee on genu varum, with  $25^\circ$  preoperative flexion contracture (a and b). TKA restored complete extension but required posterior release with osteophyte resection (c). (Thanks to Pr Hulet for images).





**Figure 4** X-rays: 30-year-old female patient presenting with juvenile polyarthritis, with bilateral 40° preoperative flexion contracture despite absence of osteophytes (a). TKA, seen here at two years' FU (b), restored complete extension but required 5 mm distal femoral resection. (Thanks to Pr Massin for images).

and the posterior capsule and lateral ligaments in particular [3], before deciding on any distal femoral cut, is to be underlined (Fig. 3). The latter is justified only in case of severe flexion contracture (> 30°) should initially be moderate (2 mm) and does not avoid the need for collateral ligament and posterior capsule release (Fig. 4). The surgeon should conserve flexion space so as not to heighten the disproportion with extension space, which is already insufficient. Finally, the importance of prolonged postoperative rehabilitation is to be stressed, progress still being possible between six months and one year postoperatively.

The study of combined stiffness showed the negative prognostic impact of hemophilia, associated with seven of the 10 poor results. The mean 19° mobility gain is average for the literature on this etiology, which ranges between 10° for Augereau et al. [10], 23° for Lachiewicz et al. [11] and 28° for Unger et al. [12]. The combined stiffness group included the most severe cases, and notably four ankyloses (2 hemophilias and two post-traumatic arthritis sequelae) in flexion (35–60°). The mean 63° mobility gain was very significant, and enabled postoperative flexion contracture to be reduced to a mean 7°, at the cost of just one infection complication. In the context of the literature, these results are satisfactory: Kim et al. [13,14] reported a mean 80° gain in mobility for a 59% complication rate, and Naranja et al. [15] a mean 55° gain in mobility for a 57% complication rate (skin necrosis, infection, extensor system rupture, femoral fractures, excessive laxity secondary to extensive release surgery, and fibular nerve palsy in case of severe flexion contracture). Ligament release sometimes has to be extensive and associated to considerable bone resection [16], which may threaten the femoral insertion of collateral ligaments. It is thus advisable to have a hinged implant ready when undertaking such surgery. In these cases of combined stiffness, the focus should generally be on the contracture, which has the greater functional impact; this was the case

in the present series, where the mean extension gain was 22°, versus 17° for flexion.

In conclusion, the exposure technique is fairly straightforward, comprising sub-quadriceps arthrolysis, and osteophyte resection to free the condylar passage of collateral ligaments [3]. The present series involved almost systematic resection of the central pivot. Posterior capsule release seems to be a prerequisite in case of flexion contracture, before undertaking extensive bone cuts, and may require a primary tibial cut with prior posterior condyle resection to achieve sufficient posterior access. Bone cuts can ideally be planned for a knee that has been released, and thus with sufficient balance and alignment in complete extension, and harmonious tension of the posterior capsule and lateral ligaments. A distal femoral cut of 2 mm is frequent, but rarely exceeded.

## Conflict of interest

None.

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